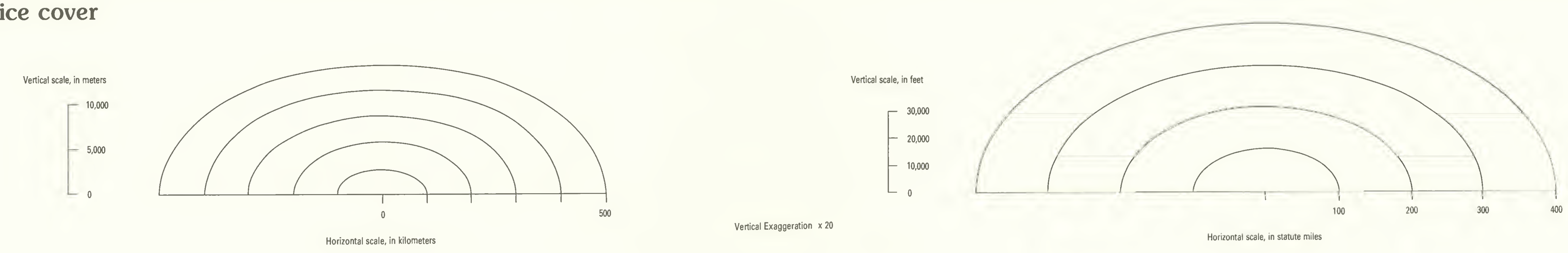
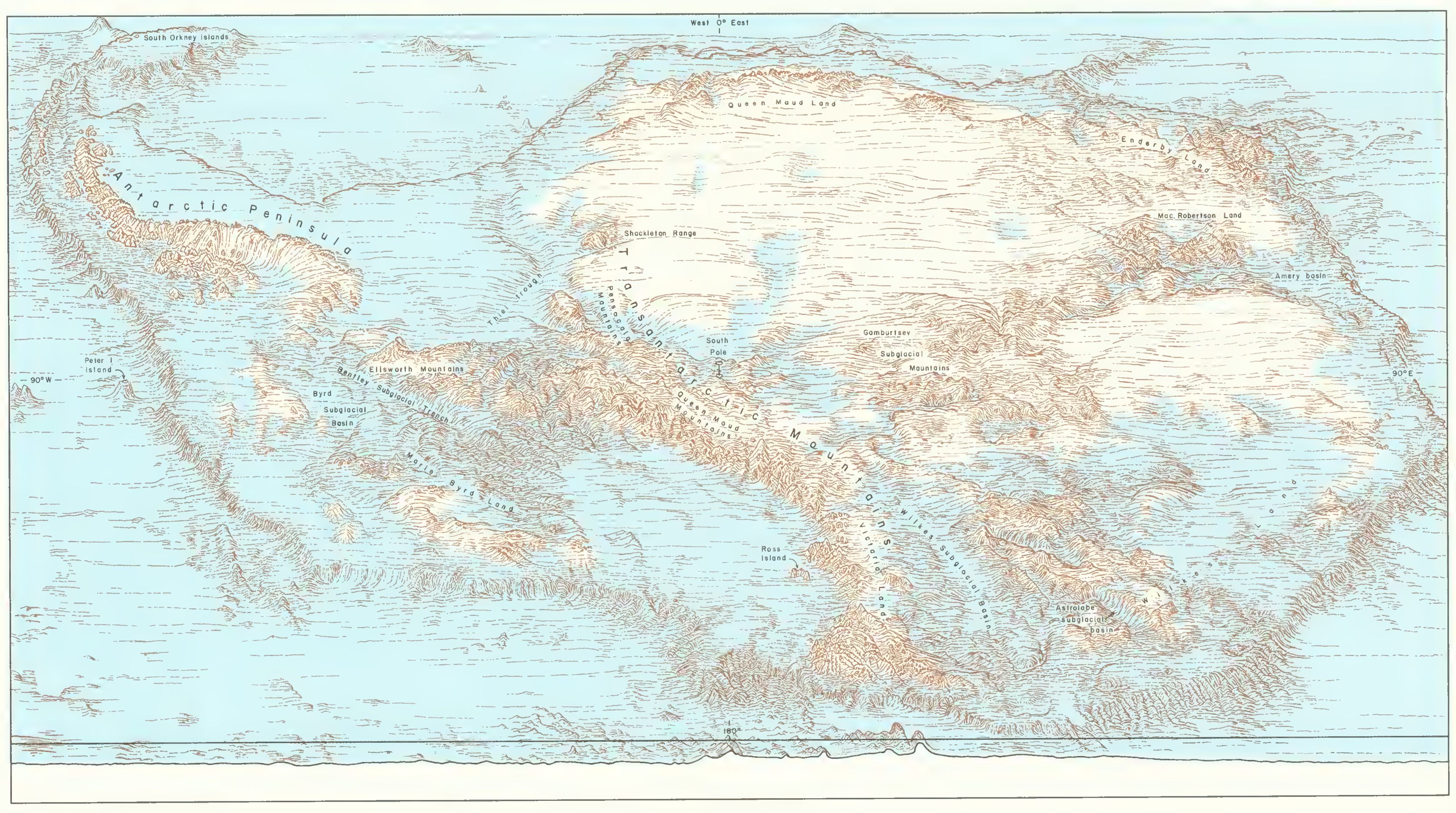
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-1992

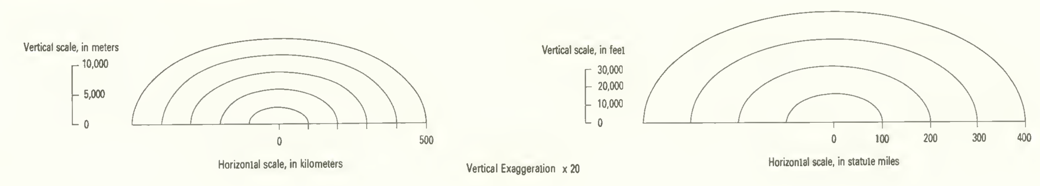
Map A – Present-day Antarctica showing ice cover

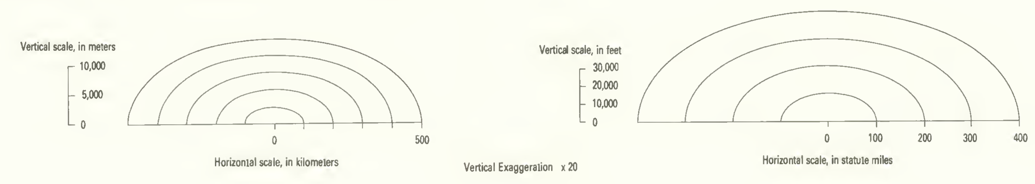


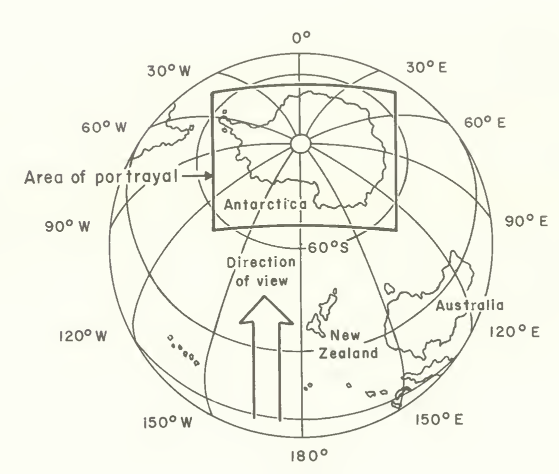


Map B – Antarctica after ice melt

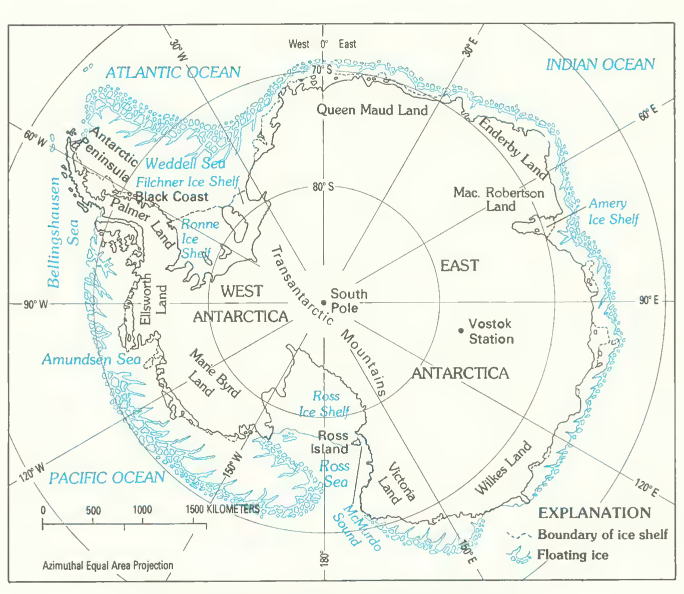
Map C – Antarctica after isostatic rebound







AREA OF MAPS



INDEX MAP OF ANTARCTICA SHOWING LOCATION OF GEOGRAPHIC FEATURES

INTRODUCTION

Antarctica, which is a name that means opposite of the Arctic, is a continent of about 13,918,000 km^2 (5.5 million mi^2) that surrounds the South Pole. An average elevation of about 2,500 m (8,000 ft) makes it by far the world's highest continent followed by Asia, about 900 m (3,000 ft). Except for the mountainous appendage of the Antarctic Peninsula, Antarctica's outline is generally circular and is deeply indented by the Ross and Weddell Seas. The continent is divided into two areas by the Transantarctic Mountains: the larger area, called East Antarctica, lies mostly in the eastern hemisphere, the smaller area, called West Antarctica, lies entirely in the western hemisphere. These two areas are also sometimes known as greater and lesser Antarctica.

Among Antarctica's many names in polar literature, the names "White Desert" and "Home of the Blizzard" are particularly apt. Despite the immense amount of potential water frozen into ice, most of Antarctica is a desert in the true sense, because the annual precipitation across the vast interior regions averages less than 10 cm (4 in.) in water equivalence of snowfall. Precipitation is much greater, however, in coastal areas. Common blizzard winds (katabatic winds) drain cold, dense air masses from high polar plateaus and may exceed 300 km/hr (200 mi/hr). Earth's lowest recorded temperature of -89.2 °C (-128.6 °F) was measured at the Soviet Union's Vostok Station in interior East Antarctica (July 21, 1983). Other than abundant coastal seabirds, few native plants and animals, such as algae, lichens, and insects, endure the harsh climate. Lovering and Prescott (1979), Bonner and Walton (1985), Ford (1986), and Walton (1987) provide general descriptions of the continent and its geology and glaciology.

The Antarctic continent, known as Terra Australis by early Greeks, was not sighted until 1820. Soon, the northern Antarctic Peninsula and a few other areas were charted in conjunction with whaling, sealing, and occasional scientific explorations. Interior regions south of the Ross Sea were visited or flown over in pioneering explorations of the early 1930's, but other areas of the continent remained little known except for the northern Antarctic Peninsula.

The mapping of Antarctica dates principally from the 1957-58 International Geophysical Year (IGY), a cooperative international effort that led to the first reconnaissance explorations of the entire continent and to the 1961 Antarctic Treaty, which has allowed wide-ranging scientific studies and mapping by many nations.

Antarctica has been mapped in ever-increasing detail since the IGY, including mapping by orbiting satellite in recent years. As part of this international mapping endeavor, the U.S. Geological Survey (USGS) has produced more than 130 topographic maps at a variety of scales, which include 1:250,000-scale maps of the entire Transantarctic Mountains, the Ellsworth Mountains, and Marie Byrd Land. Other USGS mapping includes 1:500,000-scale shaded-relief maps of northern Victoria Land and all the principal mountain areas of West Antarctica, except the Ellsworth Mountains and north half of the Antarctic Peninsula; 1:500,000-scale topographic maps of most of Wilkes Land, 1:50,000-scale topographic maps and photomaps of different scales of areas near McMurdo Sound, and satellite image maps at scales of 1:250,000 to 1:1,000,000 for the Ellsworth Mountains and the Victoria Land coast and McMurdo Sound region (U.S. Geological Survey, 1987). All major exposed mountain areas of the continent have now been visited and mapped at some scale by many nations. The last large area of previously unvisited mountains, the central Black Coast of Palmer Land (see index map), was studied in a cooperative geologic study by the British Antarctic Survey and USGS in the summer of 1986-87 (Storey and others, 1987).

Antarctica is shown in three guises on the maps presented here. The most obvious aspect, portrayed on the large map, is the present view of the continent, covered by ice, with mountain ranges and scattered tops of mountains (nunataks, which in Eskimo means lonely peak) protruding through the ice sheet. The two smaller maps portray the bedrock surface of the continent as it would look without ice cover, before and after isostatic rebound.

METHODS AND SOURCES

The oblique maps of Antarctica were prepared by isometrograph methods described in Alpha and others (1988). Map A, showing today's ice-covered continent, and map B, showing the bedrock surface without ice, are based principally on Drewry's (1983, sheets 2 and 3) contour maps at a scale of 1:6,000,000. Map C, showing the bedrock surface adjusted for isostatic rebound after loss of the ice load, is based on Drewry's (1983, sheet 6) 1:10,000,000-scale contour map. Additional data are from Behrendt and others (1974) for areas south of the Weddell Sea and the Canadian Hydrographic Service (1980), Chase and others (1987), and Davey and Cooper (1987) for areas of the Ross Sea continental shelf. Alpha (1975) provides an oblique map of the Ross Sea continental shelf.

A contour framework for the oblique maps was compiled from the source contour maps using an isometrograph and a constant viewing angle of 30° above the horizon. A view direction along the Greenwich meridian (180°-0°) was selected because it best shows principal physiographic features of the continent, such as the Transantarctic Mountains, Ellsworth Mountains, Antarctic Peninsula, and the Ross Ice Shelf. Moreover, this orientation of Antarctica, based on 0° as arbitrary north, is widely used. Contours are foreshortened from foreground to background and display a 20:1 vertical exaggeration. Distances scaled on the maps vary with orientation, from a maximum in the east-west direction to a minimum in the north-south direction, as shown in the elliptical scales of the maps. Distances are read from the scales's zero point along a direction paralleling the measurement vector on the map.

The oblique maps were completed from the compiled contour frameworks by using formlines to show physiographic interpretation of geomorphic features. Verticality of formlines shows steepness of slopes, varying from near vertical or vertical for steep slopes, such as on the Antarctic Peninsula, to near horizontal for areas of little slope, such as most of East Antarctica's ice sheet.

Geographic names used on the diagrams are primarily those approved by the United States Board on Geographic Names (Alberts, 1980, and supplements). Drewry (1983), however, uses many additional names, particularly for ice-covered features of Wilkes Land and areas to the south.

ICE AND MOUNTAINS

Antarctica's dominant feature is the immense, high ice sheet of the polar plateau of East Antarctica, which, together with the glaciers and smaller ice sheet of West Antarctica, covers all but about 2 percent of the continent's land (map A). Antarctica today shows how much of the northern United States and Canada might have looked 20,000 yrs ago when covered by the Laurentide ice sheet (Andrews, 1987). Estimated to be about 30,000,000 km^3 (7,000,000 mi^3) in volume, Antarctica's ice is about 90 percent of the world's total ice. Eighty-seven percent of Antarctica's ice is in East Antarctica, and of the remainder in West Antarctica, about 2 percent makes up the floating ice shelves of the Ross and Weddell Seas, and less than 1 percent of the ice forms the glaciers and small ice caps of the Antarctic Peninsula (Drewry, 1983, sheet 4). The ice averages 2,160 m (7,090 ft) in thickness across the continent and is 4,776 m (15,670 ft) thick at its greatest depth in East Antarctica (69°54' S., 134°12' E.) (Drewry, 1983).

The Transantarctic Mountains is one of the world's greatest mountain belts, dominating by far all other ranges of the continent. Appropriately named, the range stretches more than 3,500 km (2,000 mi) across Antarctica from the southern Pacific shores of Victoria Land to the southern Atlantic coasts of the eastern Weddell Sea, nearing the South Pole in its continental crossing. This high mountain chain that has peaks over 4,500 m (14,800 ft) high forms a generally effective barrier that prevents most ice of East Antarctica from flowing to lower regions of West Antarctica. The mountain dam is breached at various places by through-flowing glaciers that feed the Ross and Filchner-Ronne Ice Shelves or terminate in dry valleys or the sea.

Antarctica's highest mountains are in West Antarctica in the Ellsworth Mountains, where Vinson Massif (map A) reaches 5,140 m (16,860 ft). The Antarctic Peninsula, a southward extension of the Andes, is a lower but still rugged mountain chain rising from the sea to a height of 2,652 m (8,700 ft) at Mount Jackson. Generally low mountains and nunataks are scattered along the coast of East Antarctica, where the highest peaks reach 3,355 m (11,000 ft) near the Amery Ice Shelf (Prince Charles Mountains of Mac. Robertson Land) and 3,630 m (11,900 ft) in eastern Queen Maud Land (Sør Rondane Mountains). Icescapes of Marie Byrd Land are dotted by active volcanic mountains, some of which reach elevations of 3,400 m (11,200 ft) or more.

Other ranges, such as the Gumburtsev Subglacial Mountains (about 3,000 m (10,000 ft) high), lie buried under the ice sheets of interior East Antarctica. Few traverses have crossed the ice overlying these mountains, but some remote-sensing data suggest that the mountain summits in places may closely reach or possibly even breach the ice surface (J.C. Behrendt, oral commun., 1987).

THE LAND BENEATH THE ICE

Without ice, Antarctica's continental outline would be much different from the present outline. If the earth's ice melted, sea level would rise some 80 m (260 ft). The sea would cover large areas of Antarctica, and the continent would appear approximately as shown in map B.

Glaciation in Antarctica began tens of millions of years ago when glaciers that formed in the mountains built up and eventually coalesced to form piedmont glaciers and ice sheets. Ice scour on many presently exposed Antarctic peaks indicates that the ice sheets were even thicker than they are today. The lithosphere was compressed by as much as 950 m (3,000 ft) under the thickest ice in East Antarctica (Drewry, 1983). Loss of the ice load by melting would eventually result in recovery from crustal compression and consequent uplift of the land in a process of isostatic uplift (or rebound) lasting tens of thousands of years for full isostatic compensation. The oblique map of Antarctica's isostatically adjusted bedrock surface (map C) shows not only how the continent might look long after ice removal but also how it looked prior to glaciation.

The ruggedness of the bedrock surface as shown on maps B and C is highly variable, ranging from subdued relief across large regions of East Antarctica and under the Ross and Weddell Seas to high relief in most areas of presently exposed mountains as well as in central West Antarctica and areas of Wilkes Land and the Gamburtsev Subglacial Mountains. The apparent contrast in topographic relief is probably due largely to spacing of data. Most areas shown in low relief have few seismic-reflection data points and few or unreliable radio-echo survey lines, whereas data are more abundant for areas of rugged relief (Drewry, 1983, sheet 3).

After ice melt and isostatic uplift, the continent could consist chiefly of East Antarctica indented deeply by two principal marine basins: the Wilkes Subglacial Basin, and the Amery basin of Drewry (1983) near the present Amery Ice Shelf. Several smaller inland areas below sea level could be large freshwater lakes or inland seas, one of these -- Drewry's (1983) Astrolabe subglacial basin -- would exceed 1,000 m (3,280 ft) in depth. The Ellsworth Mountains would become an island chain soon after the ice melted (map B) and would be connected by a ridge to the continent after isostatic uplift. Other areas of West Antarctica would be islands or seaways (map C). The Bentley Subglacial Trench (map B) would become a marine trough more the 2,000 m (6,500 ft) deep. Other troughs over 1,500 m (5,000 ft) deep would include the Byrd Subglacial Basin and the Thiel trough of Drewry (1983) west of the Pensacola Mountains.

ACKNOWLEDGMENTS

Our indebtedness to all mappers of Antarctica from the early 1900's pioneering age to today's satellite age is implicit. We particularly acknowledge David A. Drewry, British Antarctic Survey (Cambridge), for use of his maps published in 1983. Alan K. Cooper, John C. Behrendt, and Baerbel K. Lucchitta provided helpful discussions and comments on an earlier version of these oblique maps.

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OBLIQUE MAPS OF ANTARCTICA

By
Tau Rho Alpha and Arthur B. Ford
1989

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